TileCal PMT Channel Calibration Using Laser Pulses Sent in Empty Bunches During Physics Runs

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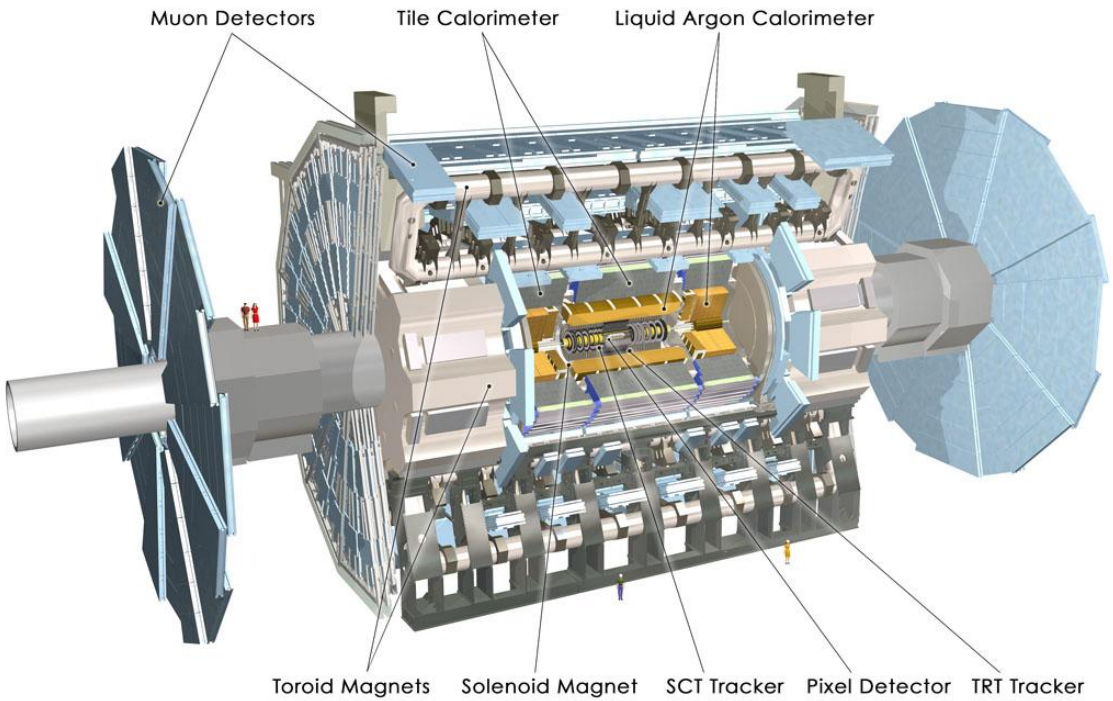
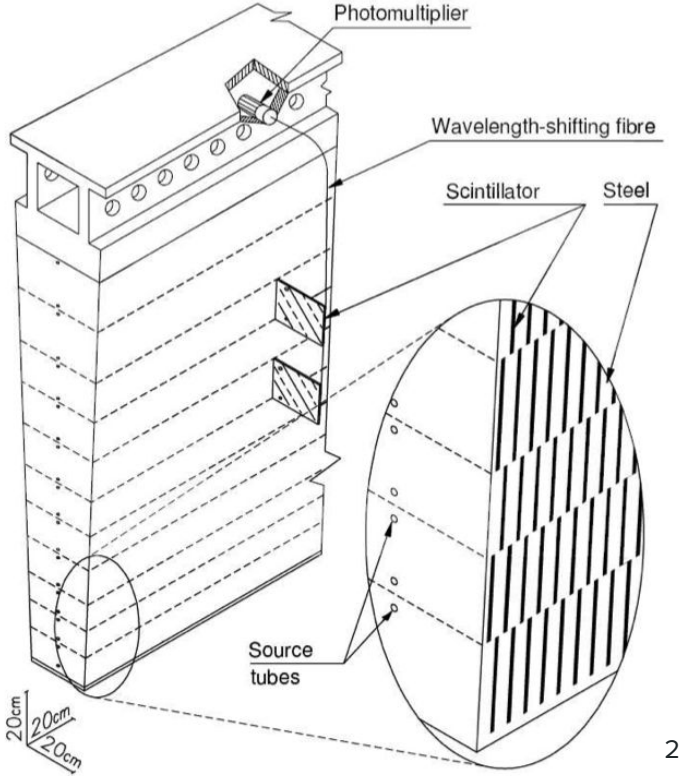
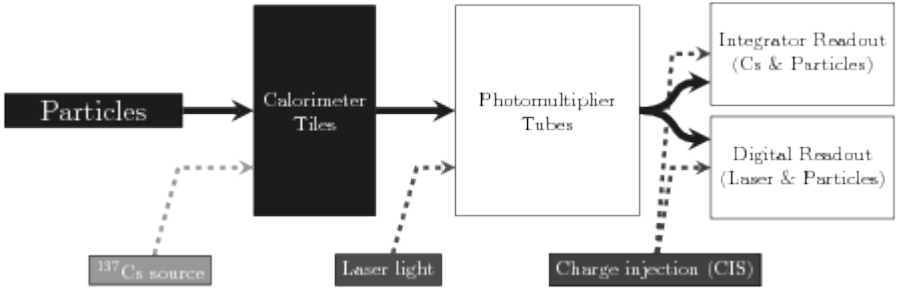
The ATLAS Tile Calorimeter (TileCal)

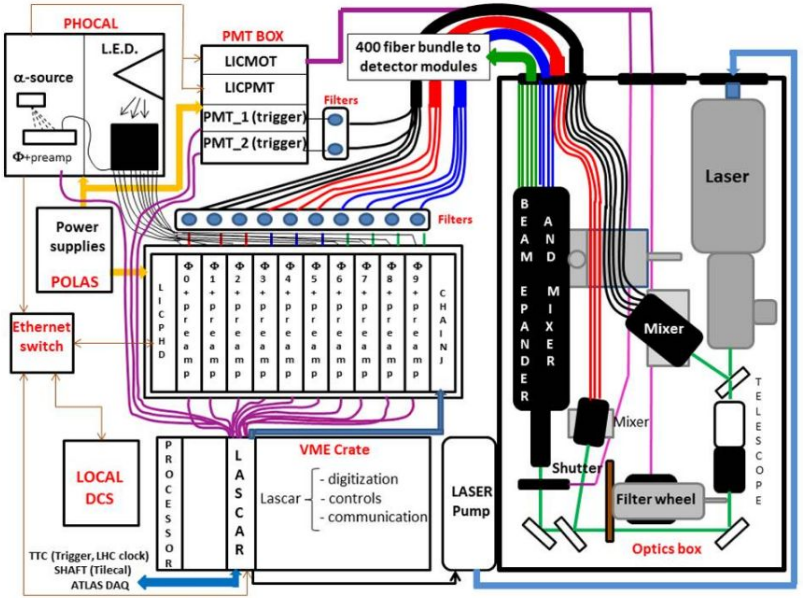




TileCal Calibration



The Full LaserII System:



Three Complementary Systems Calibrate the three main elements of the readout chain.

The reconstructed energy of each channel is derived from the raw ADC response:

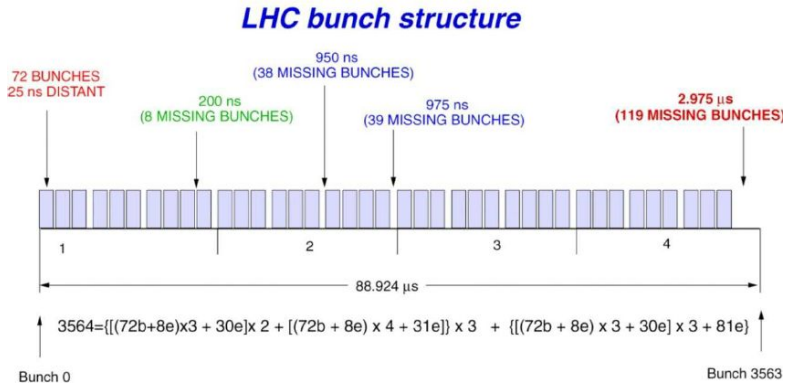
$$E(GeV) = A(ADC) \times C_{ADC \to Pc} \times C_{pC \to GeV} \times C_{Cesium} \times C_{Laser} \times C_{CIS}$$

Laser Pulses in Empty Bunches

Until now the calibration procedure has been based on the assumption that the PMT response is stable throughout a run - so current practice is to calculate the laser calibration constant only after each calibration run

The aim of this study is to characterize the evolution of the PMT response during a physics run and between physics runs and the most recent calibration runs

Wait, What are Empty Bunches?



The protons of each beam are grouped into bunches separated by 25 ns

There are intervals of 25 ns with no protons i.e. “empty bunches”

At the time in which empty bunches intersect at an interaction point laser pulses are sent to all TileCal channels

The Road to Results: For a Given Set of Cells (i.e. A10 left LBA)

Identify bad channels flagged with CHSTATUS !=12 in physics run and most recent calibration run and exclude

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For each PMT Channel Loop through events in run and do three cases:

Response of each channel

Response of Each Channel normalized to diode 6

Response of Each Channel normalized to diode 0

Average over all events in a 25 LumiBLock Period → A[i][k] i over LB Bin and j over each channel

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If average outside the tails of the distribution (or RMS is large) make a cut on these channels

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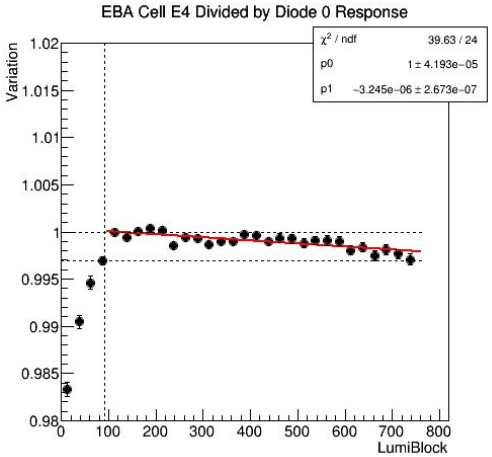
For each i Average A_n over all modules associated to particular cell

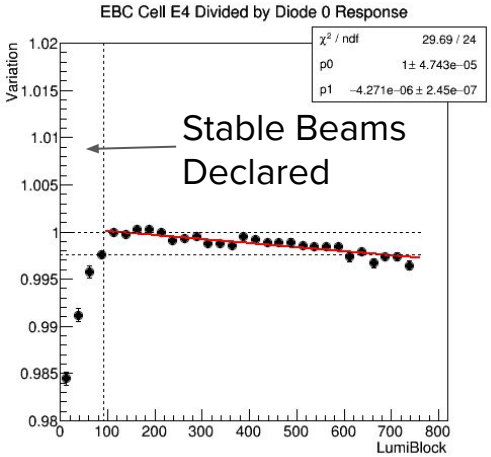
Plot these averages as a function of LumiBlock for each Cell

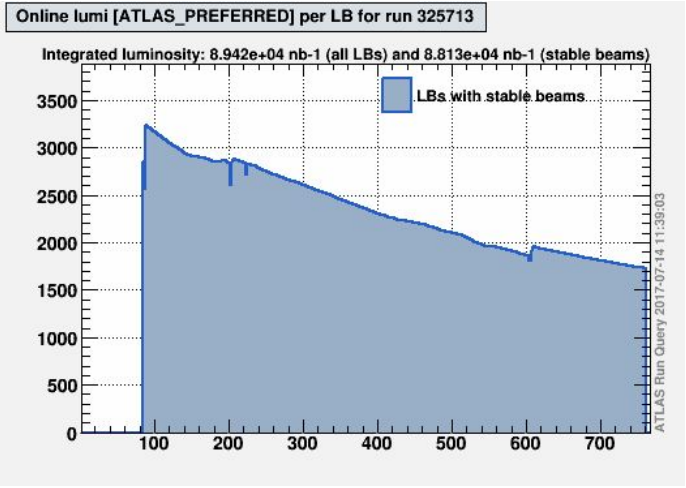
Run 325713: Expected time profile

Mon June 5 2017 00:23:29

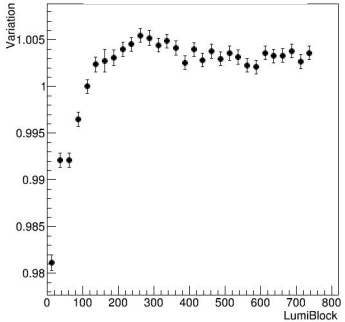
Peak Luminosity: $3.2 \times 10^{33} cm^{-2} s^{-1}$

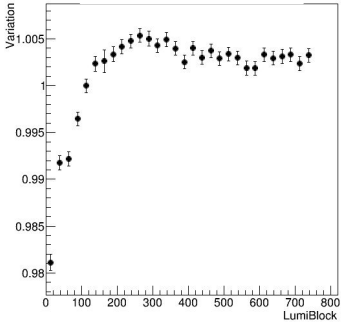


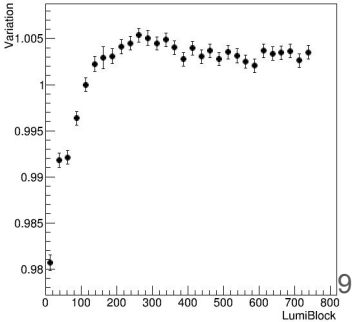




Laser Intensity Monitors:



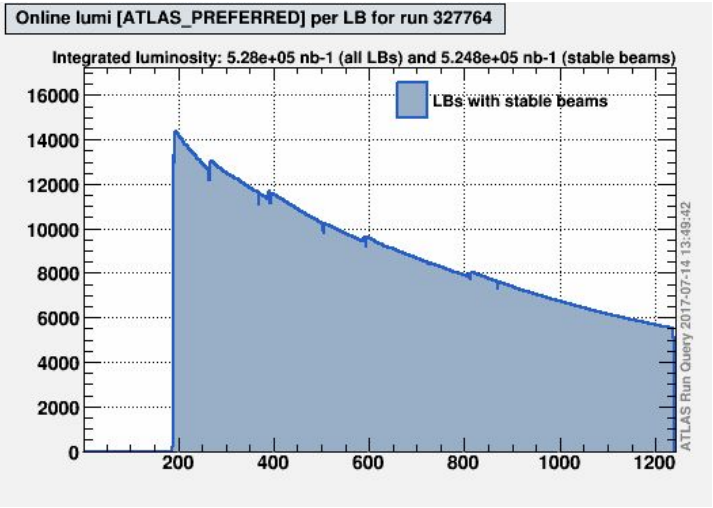


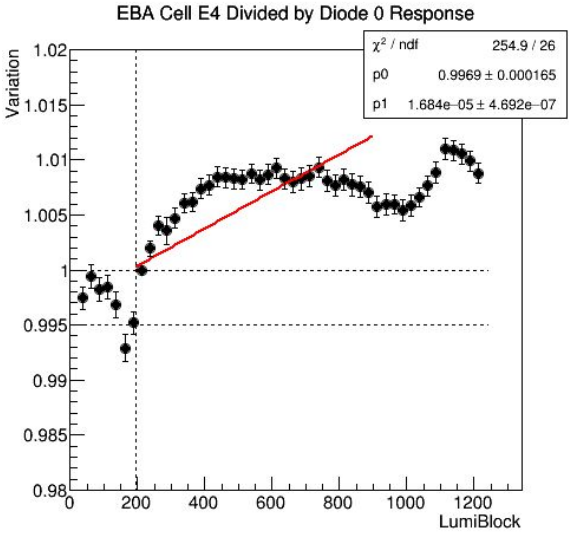


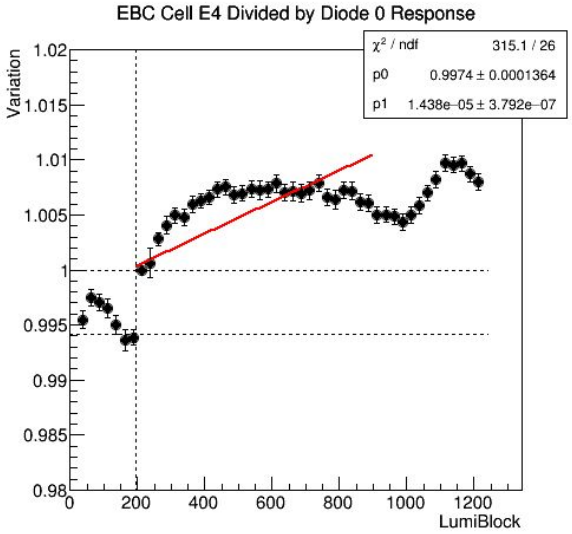
Run 327764: An example of anomalous time profile

Sun Jun 25 2017 04:38:39

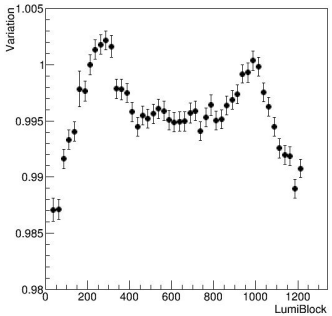
Peak Luminosity:
$1.4 \times 10^{34} cm^{-2} s^{-1}$

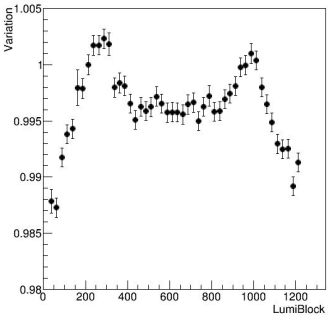


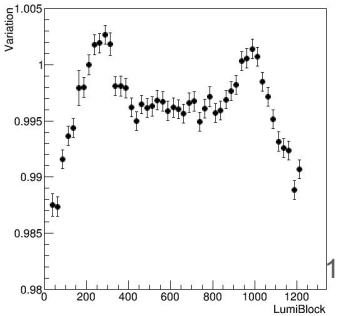




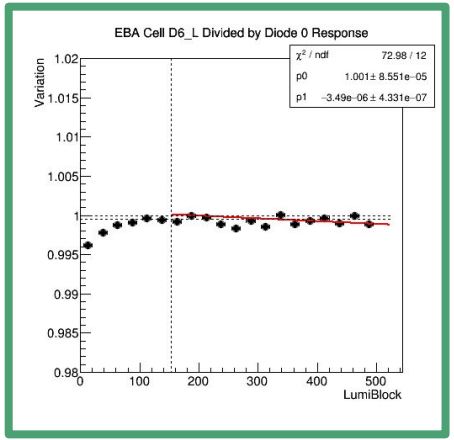
Laser Intensity Monitors:

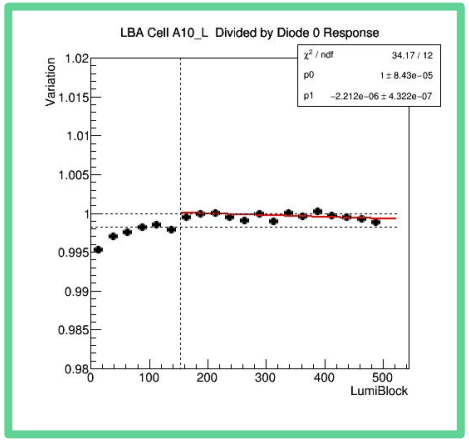


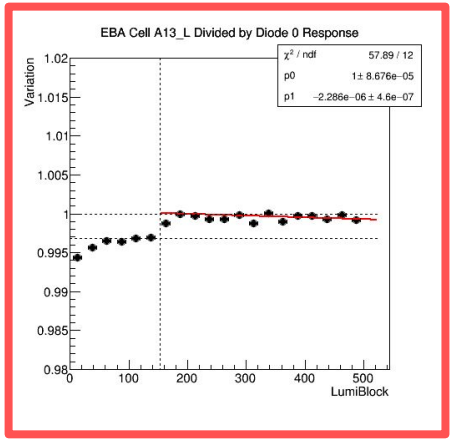


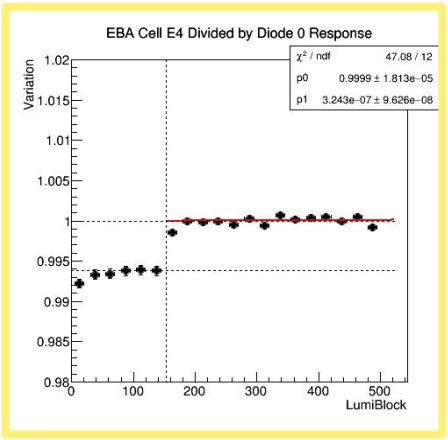


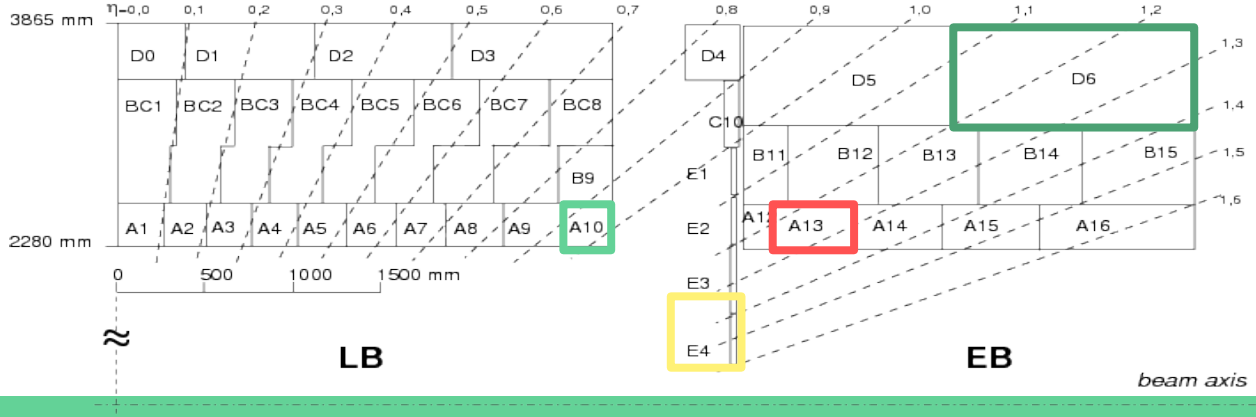
Run 325790 Peak Luminosity: $2.9 \times 10^{33} cm^{-2} s^{-1}$





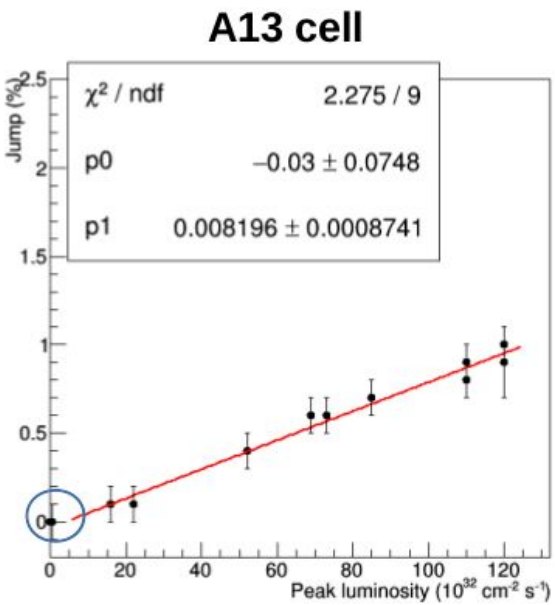






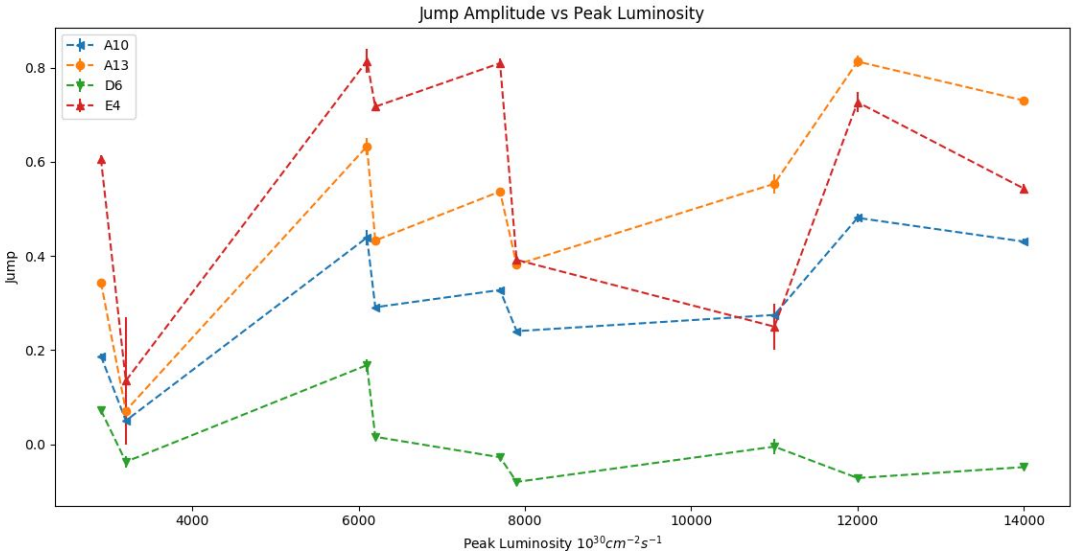
Jump Amplitude versus Peak Luminosity

2016 Runs



Clear trend observed

June 2017 Runs



No clear trend observed

Conclusions

1. A study of the time evolution of the PMT response in individual 2017 collision runs was performed.
2. In all analyzed runs with stable laser conditions the main features already observed in 2015-2016 were confirmed.
   a. Turn on Curve
   b. Jump in the PMT response of the most exposed cells when stable beams are declared
   c. Linear Drift after Stable Beams Declared
3. This work was presented at the TIleCal Data Preparation Weekly Meeting
4. A comparison between physics runs and most recent calibration runs is in progress and more time is needed to finalize the results
5. A package to evaluate the PMT gain evolution was prepared but more time is needed to finalize the results
6. This entire study should be repeated using 2017 runs with stable laser and beam conditions
7. Learned: Structure and operation of the ATLAS detector, operation of the Calibration system of the ATLAS hadron calorimeter (TileCal), software architecture used in the TileCal laser calibration, and modifying python scripts and ROOT macros for analysing new 2017 data samples.

Thank You NSF, UMich, Dr Scuri, Dr Wilkens, Giulia DiGregorio, Steven Goldfarb, Cari Cesarotti, and most of all these babes:

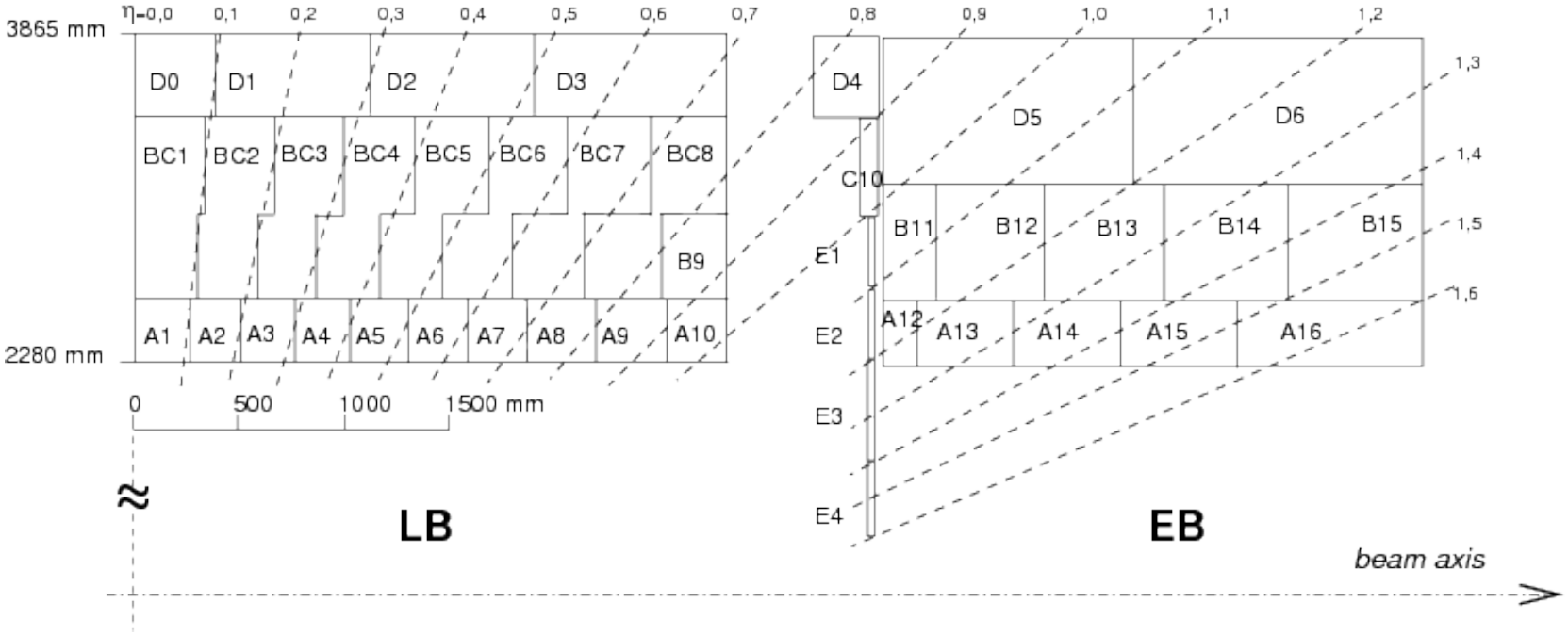
References

1. Scuri, F. Performance of the atlas tile laserii calibration system. Unpubl. .

2. Calvet, D. The laser calibration of the atlas tile calorimeter during the lhc run 1. Unpubl. (2016).

3. Boumediene, D. Calibration of the tile hadronic calorimeter of atlas at lhc. Unpubl. .

Backup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0,1
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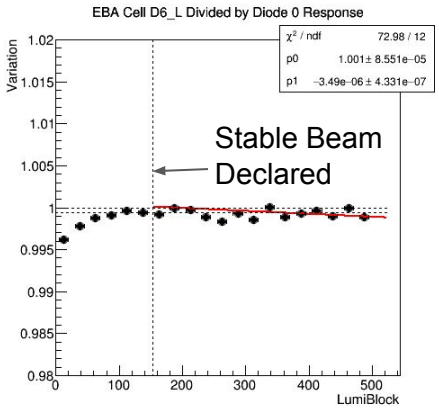
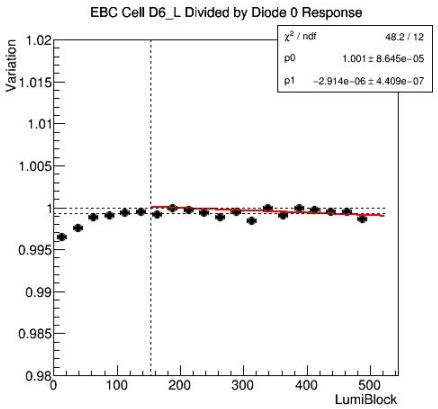
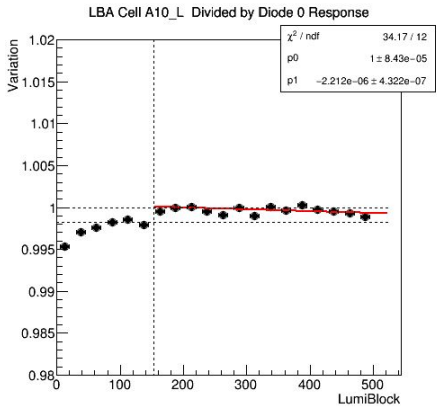
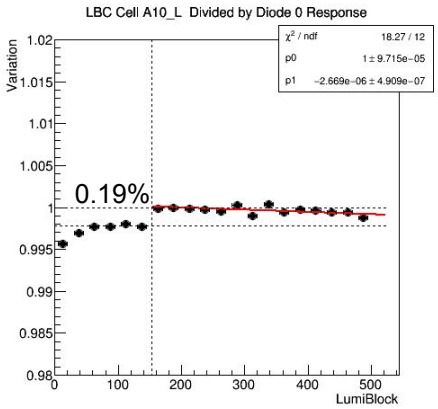
0,3
0,4
0,5
0,6
0,7
0,8
0,9
1,0
1,1
1,2
1,3
1,4
1,5
1,6
3865 mm
2280 mm
D0
D1
D2
D3
D4
D5
D6
BC1
BC2
BC3
BC4
BC5
BC6
BC7
BC8
B9
C10
B11
B12
B13
B14
B15
A1
A2
A3
A4
A5
A6
A7
A8
A9
A10
A12
A13
A14
A15
A16
E1
E2
E3
E4
0
500
1000
1500 mm
LB
EB
beam axis

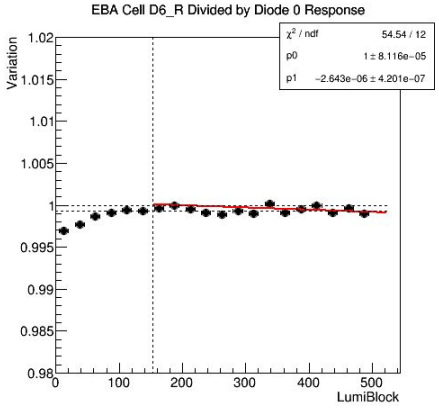
Run 325790 Peak Luminosity: 2.9e33cm^{-2} s^{-1}

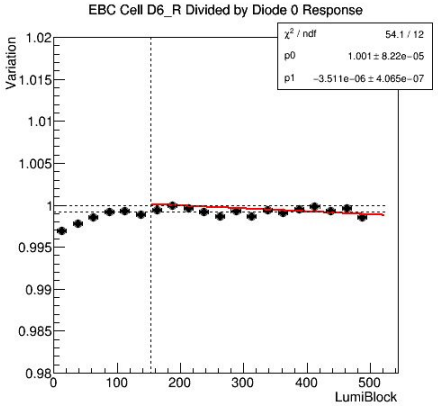


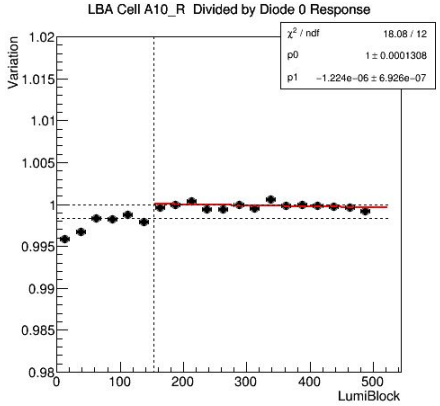


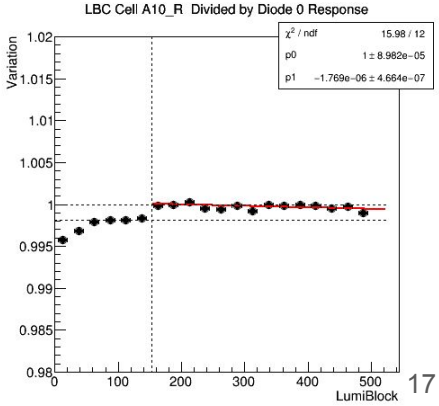












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